Activity MS.2.4: The Carbon Cycle Game

Overview

In this lesson, students will take the role of a carbon atom, record which reservoirs in the carbon cycle they visit, and discover information about sources and sinks by comparing and contrasting their trip with those of their classmates.

Objectives

On successful completion of this lesson, students will be able to:

- model the movement of carbon through different reservoirs
- compare and contrast fast and slow processes (or short and long residence times) that move carbon
- describe, using a diagram, that the path taken by an atom through a biogeochemical cycle is complex, not a cycle
- describe the process of photosynthesis, respiration and decomposition

Next Generation Science Standards

Standards by Disciplinary Core Ideas:

Ecosystems: Interactions, Energy, and Dynamics
From Molecules to Organisms: Structures and Processes

Standards by Topic: Matter and Energy in Organisms and Ecosystems

Performance Expectations

The activity is just one step toward reaching the performance expectations listed below:

MS-LS2-3: Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

MS-LS1-6: Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

Dimention:

Science & Engineering Practices

Developing and Using Models
Constructing Explanations and Designing Solutions
Connections to Nature of Science

Disciplinary Core Ideas

LS2.B: Cycles of Matter and Energy Transfer in Ecosystems

- Food webs are models that demonstrate how matter and energy is transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. (MS-LS2-3)

PS2.D: Energy in Chemical Processes and Energy Life

- The chemical reaction by which plants produce complex food molecules (sugars) requires an energy input (i.e., form sunlight) to occur. In this reaction, carbon dioxide and water combine to form carbon-based organic molecules and release oxygen. (secondary to MS-LS1-6)

LS1.C: Organization for Matter and Energy Flow in Organisms

- Plants, algae (including phytoplankton), and many microorganisms use the energy from light to make sugars (food) from carbon dioxide from the atmosphere and water through the process of photosynthesis, which also releases oxygen. These sugars can be used immediately or stored for growth or later use. (MS-LS1-6)

Crosscutting Concepts

Energy and Matter

Alaska Standards

Alaska Science Standards and Grade Level Expectations

SA1: The student demonstrates an understanding of the processes of science by

[6-8] SA1.1 asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating

SC3: The student demonstrates an understanding that all organisms are linked to each other and their physical environments through transfer and transformation of matter and energy by

[6] SC 3.1 recognizing that organisms can cause physical and chemical changes (e.g., digestion, growth, respiration, photosynthesis) to matter and recognizing the importance of energy transfer in these changes

[7] SC 3.1 recognizing and explaining that organisms can cause physical and chemical changes (e.g., digestion, growth, respiration, photosynthesis) to matter and recognizing and explaining the importance of energy transfer in these changes

[8] SC 3.1 stating that energy flows and that matter cycles but is conserved within an ecosystem

SD3: The student demonstrates an understanding of cycles influenced by energy from the sun and by Earth's position and motion in our solar system by

[6] SD 3.2 identifying that energy transfer is affected by surface conditions (e.g., snow cover, asphalt, vegetation) and that this affects weather

SF: The student develops an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives.

Bering Strait School District Scope and Sequence

6.3B Diagram the ways that matter and energy are transferred within and between living and nonliving things. (SC3.1)

6.3E Name and describe the processes involved in the water cycle, carbon and oxygen cycles.

6.3H Use scientific processes and inquiry to directly support concepts of cycling of matter and energy.

7.7A Understands composition and structure of the atmosphere (gases present and layers)

7.7C Knows that atmosphere is warmed through heat retention (greenhouse effect). (SD3.2)

7.7D Understand that the atmosphere protects life on earth by absorbing ultraviolet solar radiation.

Materials

- Template: *Carbon Reservoir Station Signs*
- Information Sheet: *Dice Number Charts*
- Dice
- Student Worksheet: *The Carbon Cycle Game*
- Student Worksheet: *The Carbon Cycle Review*

Activity Preparations

1. Make copies of the Student Worksheet: *The Carbon Cycle Game*. (One per student, extra copies if you want to play the game more than once.)
2. Make copies of the Student Worksheet: *The Carbon Cycle Review*.
3. Make copies of the Information Sheet: *Dice Number Charts*
4. If needed, make copies of the Carbon Reservoir Station Cards. There are 11 stations. 5 of the stations (Atmosphere, Surface Ocean, Soil, Land Plants, and Land Animals) are the same ones found in Activity MS.2.3: You Are a Carbon Atom! For this activity, you

will need 6 additional signs: Ocean Plants, Ocean Animals, Deep Ocean (Particles), Deep Ocean (Dissolved), Ocean Sediments, and Fresh Water.

5. Set up each of the eleven stations (reservoirs) in a different location around the room. Mark each station clearly with the Carbon Reservoir Station Card so students can easily see where to go next. Place the corresponding Dice Number Chart and dice at each station. (To determine the number of dice for each station, see Activity Procedure #5 below.)

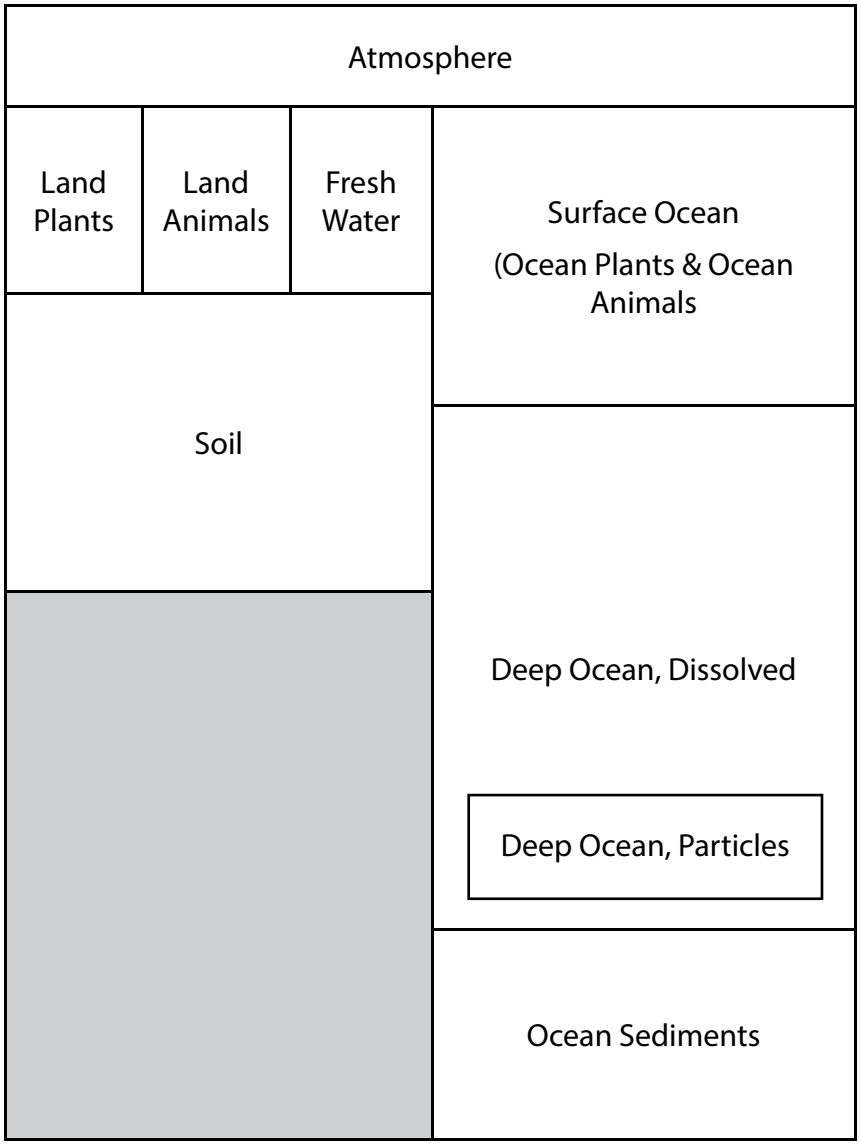
Activity Procedure

1. Pre-Teaching: Introduce/review the carbon cycle. Ideally, you will teach this lesson after you taught REACH Up Lesson MS.2.3, and can lead a brief review of that activity. Read and discuss pages 2-4 of the REACH Up Middle School Student Guide: Environmental Cycles. Review the water cycle as a familiar concept, and introduce terms such as reservoir, source, and sink. Review with students why carbon is important to biology and climate. At the end of the session, ask students to list different carbon sources and sinks.
2. Instruct students to imagine they are a carbon atom moving through the carbon cycle. in this activity by visiting the ten places where carbon is stored (which you set up in #5 above). Review the water cycle as a familiar concept, if necessary, and introduce terms such as source and sink, using the water cycle as an example.
3. Go over what sources and sinks will be included in this carbon cycle activity. Point out that there are many other sources and sinks that are not included in this activity, such as fossils fuels and vehicle emissions.
4. Read Page 10 of the Student Guide as a class and review the rules of the game:
    a. Each student will participate in the game individually. Even though several students may start at the same station, they should take turns and each roll the die for themselves.
    b. Students will keep track of their journey by writing the name of each reservoir they visit on the Student Worksheet: The Carbon Cycle Game, starting with row 1 and ending with row 15.
    c. Students should write the name of the reservoir first, so they don't forget, then roll the die.
    d. Consulting the Dice Number Chart, students should read the information, written next to the number of the die they got for each reservoir, about the process that is moving them from one reservoir to another, and then go to their next station as instructed by the die.
    e. If a die tells them to stay in place for a turn, they should write the name of that reservoir in the next row of the chart before re-rolling.
    f. Students represent carbon, i.e., an element. Therefore, they don't "want" to go to any particular place. Each turn they should roll the die only ONCE, and follow the explanation listed by the number they rolled. (Monitor students for this.)

g. Students should continue moving through the cycle until they have filled out a total of 15 rows on the first part of their worksheet.

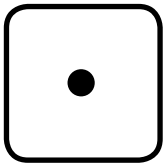
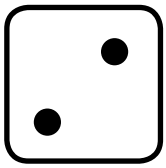
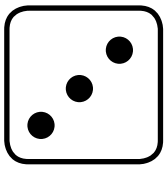
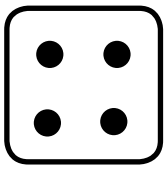
5. Give students their starting location. The carbon cycle is a large and complex topic, so how you distribute them may depend on the connections you would like to make during the discussion portion.
   a. If you would like to discuss residence time, start a couple of students in the Atmosphere and Surface Ocean, and a couple in the Ocean Sediments and Deep Ocean, Dissolved reservoirs. (In such a case, it will be helpful to have multiple dice for some stations. If you would like six students to start in the Atmosphere, for example, you may want to have six dice at the Atmosphere station.)
   b. If you would like to discuss the biological pump, start all students in the Atmosphere and Surface Ocean and make sure no student will start in the Deep Ocean, Particle or Ocean Sediments stations.
   c. Once students get the hang of it, the game goes quickly, so if you have enough time (and extra copies of the worksheet) you can certainly run the game more than once, with a slightly different focus each time.
6. Monitor students as they move through the game and remind them of the rules if needed.
7. When students have finished their cycle, point them to the second part of Student Worksheet: The Carbon Cycle Game. Have them use the diagram to represent the journey through the cycle as a series of arrows. If students stayed in the same reservoir, they must add a horizontal arrow for each time they stayed in the same reservoir. You may want to demonstrate a few examples (see answer key for an example.)
8. Have students fill out the last part of the Student Worksheet: The Carbon Cycle Game. Then discuss the journeys students took as a class. (See Discuss section on Page 10 of the Student Guide.)Possible discussion topics include:
   a. Overall, which reservoirs were visited most?
   b. Which reservoirs have long residence times and which have short residence times?
   c. What are the processes that move carbon from one reservoir to another? (Choose a few to highlight.)
   d. Is the carbon cycle a circle?

9. **Optional**: Diagram the global distribution of carbon by diagramming the students' game experience. See the chart below. Display this chart with a digital projector or recreate on the board. Ask each student to verbally describe which reservoirs they visited and how many times, and place tally marks for each. Alternatively, you could have students come up and write the tally marks on the boards themselves. When all the students journeys through the carbon cycle have been counted, you should see the most tally marks in the ocean, for example, demonstrating that that ocean is the largest carbon sink.

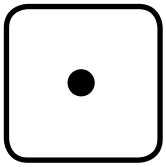
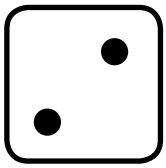
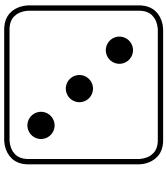
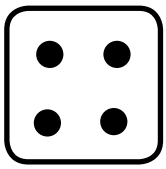


10. When students have completed MS.2.3 "You are a Carbon Atom!" and MS.2.4 "The Carbon Cycle Game," distribute Student Worksheet: The Carbon Cycle Review. Have them answer questions individually, then review the carbon cycle as a class.

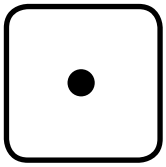
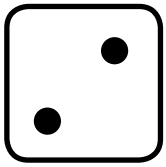
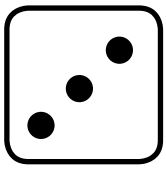
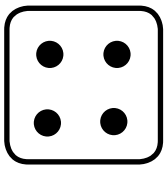
ATMOSPHERE

1 	You are carbon in the form of CO_2. You stay in the Atmosphere. Roll the die again.
2 	You are carbon in the form of CO_2. You dissolve in water. Go to Surface Ocean.
3 	You are carbon in the form of CO_2. You are taken up by the plant for photosynthesis. Go to Land Plants.
4 	You are carbon in the form of CO_2. You dissolve in water. Go to Surface Ocean.
5 	You are carbon in the form of CO_2. You dissolve in water. Go to Fresh Water.
6 	You are carbon in the form of CO_2. You dissolve in water. Go to Surface Ocean.

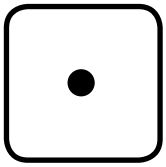
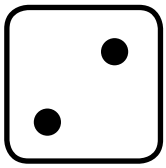
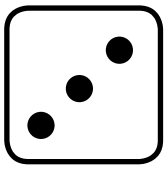
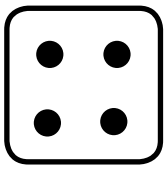
SURFACE OCEAN

1 	You are dissolved carbon. You are released into the atmosphere as CO_2. Go to Atmosphere.
2 	You are carbon in the form of CO_2. You are taken up by the plant for photosynthesis. Go to Ocean Plants.
3 	You are dissolved carbon. You are released into the atmosphere as CO_2. Go to Atmosphere.
4 	You are dissolved carbon. You are stored in the ocean. Roll the die again.
5 	You are carbon in the form of CO_2. You are taken up by the plant for photosynthesis. Go to Ocean Plants.
6 	You are dissolved carbon. You are released into the atmosphere as CO_2. Go to Atmosphere.

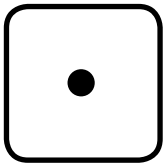
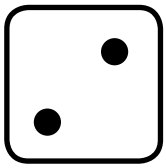
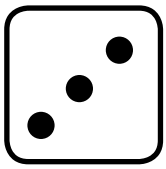
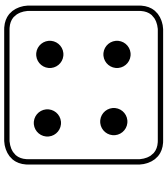
LAND PLANTS

1 	The plant you were a part of decomposed. Go to Soil.
2 	You are carbohydrate in the plant which has been eaten by an animal. Go to Land animals.
3 	You are carbohydrate being stored in the plant, or used to grow more plants. Roll the die again.
4 	You are in plant matter that has washed into a stream or lake. Go to Fresh Water.
5 	You are carbohydrate in the plant which has been eaten by an animal. Go to Land animals.
6 	You are carbohydrate in the plant, respired to provide energy. You are released into atmosphere as CO_2. Go to Atmosphere.

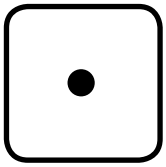
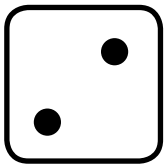
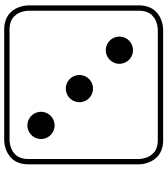
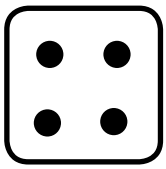
LAND ANIMALS

1 	You are carbohydrate the animal ate, respired to provide energy. You are released into the atmosphere as CO_2. Go to Atmosphere.
2 	The animal you were part of was eaten by another animal. Stay in Land Animals. Roll the die again.
3 	The animal you were part of has died and decomposed. Go to Soil.
4 	The animal you were part of was eaten by another animal. Stay in Land Animals. Roll the die again.
5 	You are carbohydrate the animal ate, respired to provide energy. You are released into the atmosphere as CO_2. Go to Atmosphere.
6 	You are carbon in animal waste that has washed into a stream or lake. Go to Fresh Water.

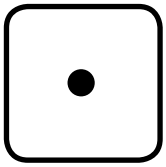
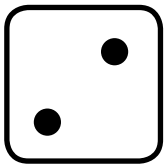
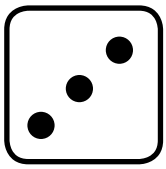
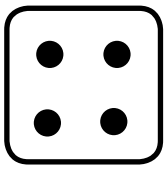
SOIL

1 	You are carbon in the organic matter in soil, and you stay in the soil. Roll the die again.
2 	You are carbon in the organic matter in soil, and you stay in the soil. Roll the die again.
3 	You are carbon in the organic matter in soil, and you stay in the soil. Roll the die again.
4 	You are carbon in the organic matter in soil, and you stay in the soil. Roll the die again.
5 	You are carbon in the organic matter in soil, and you stay in the soil. Roll the die again.
6 	You are broken down by bacteria and respired as CO_2. Go to Atmosphere.

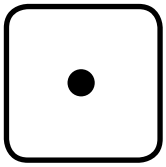
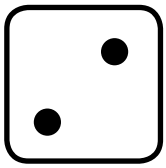
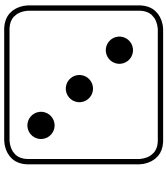
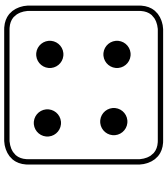
OCEAN PLANTS

1 	You are carbohydrate in the plant which has been eaten by an animal. Go to Ocean Animals.
2 	You are carbohydrate in the plant, respired to provide energy. You are released into the surrounding water as CO_2. Go to Surface Ocean.
3 	You are carbohydrate in the plant which has been eaten by an animal. Go to Ocean Animals.
4 	You are carbohydrate in the plant that has died. The dead plant sinks, carrying you into the deep ocean. Go to Deep Ocean, Particles.
5 	You are carbohydrate in the plant, respired to provide energy. You are released into the surrounding water as CO_2. Go to Surface Ocean.
6 	You are carbohydrate in the plant which has been eaten by an animal. Go to Ocean Animals.

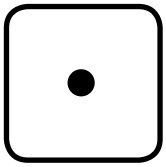
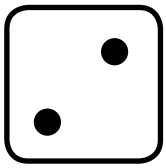
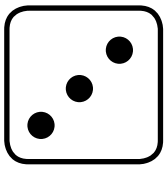
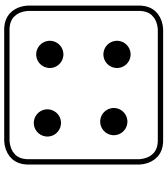
OCEAN ANIMALS

1 	You are carbohydrate the animal ate, respired to provide energy. You are released into the surrounding water as CO_2. Go to Surface Ocean.
2 	You are carbohydrate the animal ate, respired to provide energy. You are released into the surrounding water as CO_2. Go to Surface Ocean.
3 	The animal you were part of was eaten by another animal. Stay in Ocean Animals. Roll the die again.
4 	You are carbon in animal waste, or the body of an animal that has died. The waste/dead animal sinks, carrying you into the deep ocean. Go to Deep Ocean, Particles.
5 	You are carbohydrate the animal ate, respired to provide energy. You are released into the surrounding water as CO_2. Go to Surface Ocean.
6 	The animal you were part of was eaten by another animal. Stay in Ocean Animals. Roll the die again.

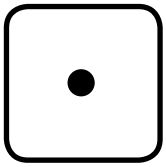
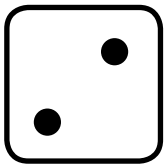
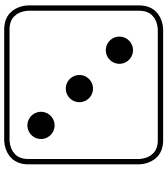
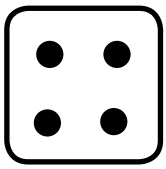
DEEP OCEAN, PARTICLES

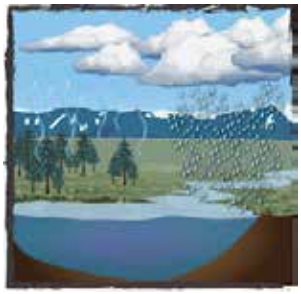
1 	You are carbon in waste, respired by bacteria to provide energy. You are released into the surrounding water as CO_2. Go to Deep Ocean, Dissolved.
2 	You are carbon in waste, respired by bacteria to provide energy. You are released into the surrounding water as CO_2. Go to Deep Ocean, Dissolved.
3 	You are carbon in waste or dead stuff. Particles continue drifting in deep ocean currents. Roll the die again.
4 	You are carbon in waste, respired by bacteria to provide energy. You are released into the surrounding water as CO_2. Go to Deep Ocean, Dissolved.
5 	You are carbon in waste or dead stuff. The particle sinks, carrying you to the sediment on the seafloor. Go to Ocean Sediments.
6 	You are carbon in waste, respired by bacteria to provide energy. You are released into the surrounding water as CO_2. Go to Deep Ocean, Dissolved.

DEEP OCEAN, DISSOLVED

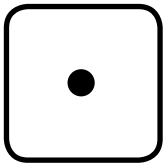
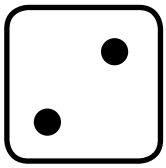
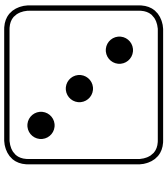
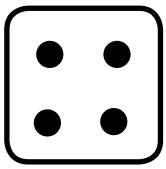
1 	You are dissolved carbon. Upwelling brings deep water to the surface. Go to Surface Ocean.
2 	You are dissolved carbon. You are stored in water drifting in slow deep ocean currents. Roll the die again.
3 	You are dissolved carbon. You are stored in water drifting in slow deep ocean currents. Roll the die again.
4 	You are dissolved carbon. You are stored in water drifting in slow deep ocean currents. Roll the die again.
5 	You are dissolved carbon. Upwelling brings deep water to the surface. Go to Surface Ocean.
6 	You are dissolved carbon. You are stored in water drifting in slow deep ocean currents. Roll the die again.

OCEAN SEDIMENTS

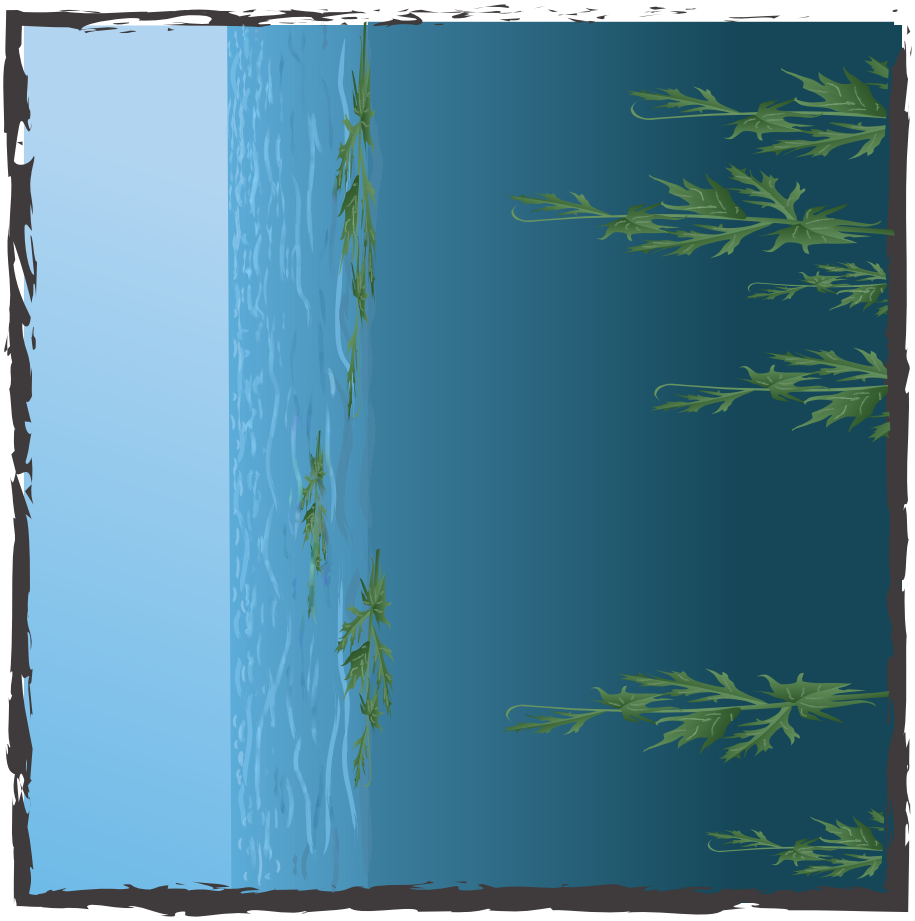
1 	You are carbon in the top layer of the sediments. You are respired by bacteria to provide energy and released into the surrounding water as CO_2. Go to Deep Ocean, Dissolved.
2 	You are carbon in dead plants and animals. You are covered by sediments and buried. Roll the die again.
3 	You are carbon in dead plants and animals. You are covered by sediments and buried. Roll the die again.
4 	You are carbon in dead plants and animals. You are covered by sediments and buried. Roll the die again.
5 	You are carbon in dead plants and animals. You are covered by sediments and buried. Roll the die again.
6 	You are carbon in dead plants and animals. You are covered by sediments and buried. Roll the die again.



FRESH WATER

1 	You are dissolved carbon. Rain, freshwater runoff, or a river carries you to the ocean. Go to Surface Ocean.
2 	You are dissolved carbon. You are released into the atmosphere as CO_2. Go to Atmosphere.
3 	You are dissolved carbon. You are stored in a lake or river. Roll the die again.
4 	You are carbon in the form of CO_2. You are taken up by the plant for photosynthesis. Go to Land Plants.
5 	You are dissolved carbon. Rain, freshwater runoff, or a river carries you to the ocean. Go to Surface Ocean.
6 	You are dissolved carbon. You are released into the atmosphere as CO_2. Go to Atmosphere.

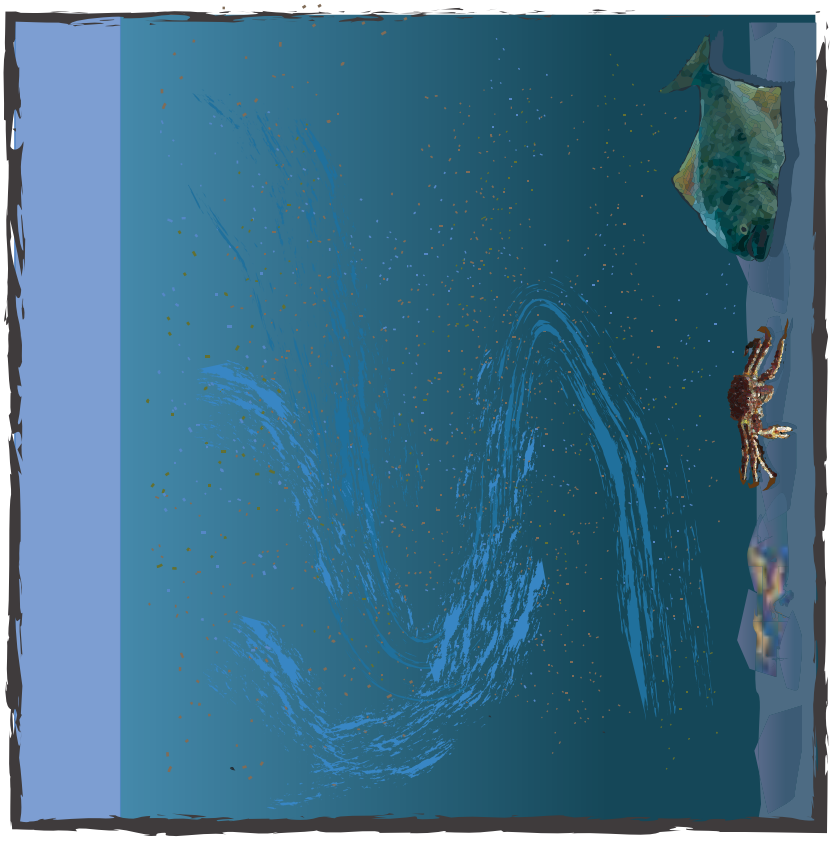
OCEAN PLANTS



OCEAN ANIMALS

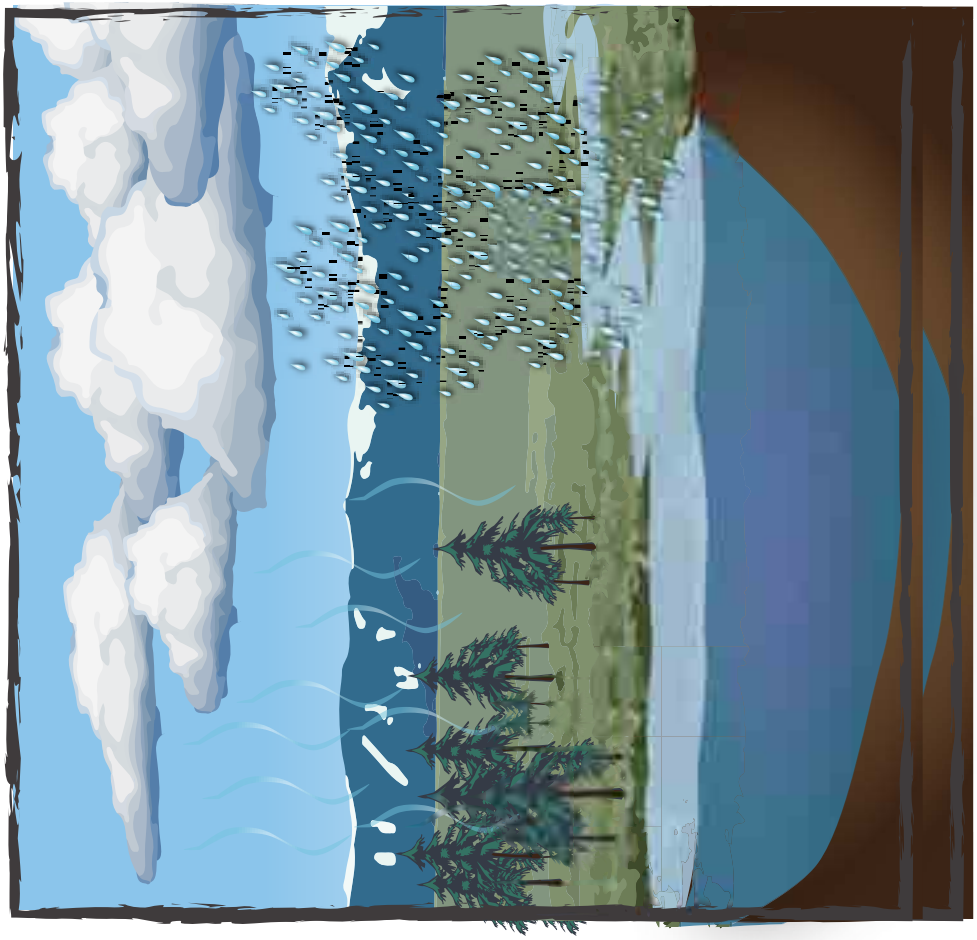
DEEP OCEAN PARTICLES

DEEP OCEAN DISSOLVED



OCEAN SEDIMENTS

FRESH WATER



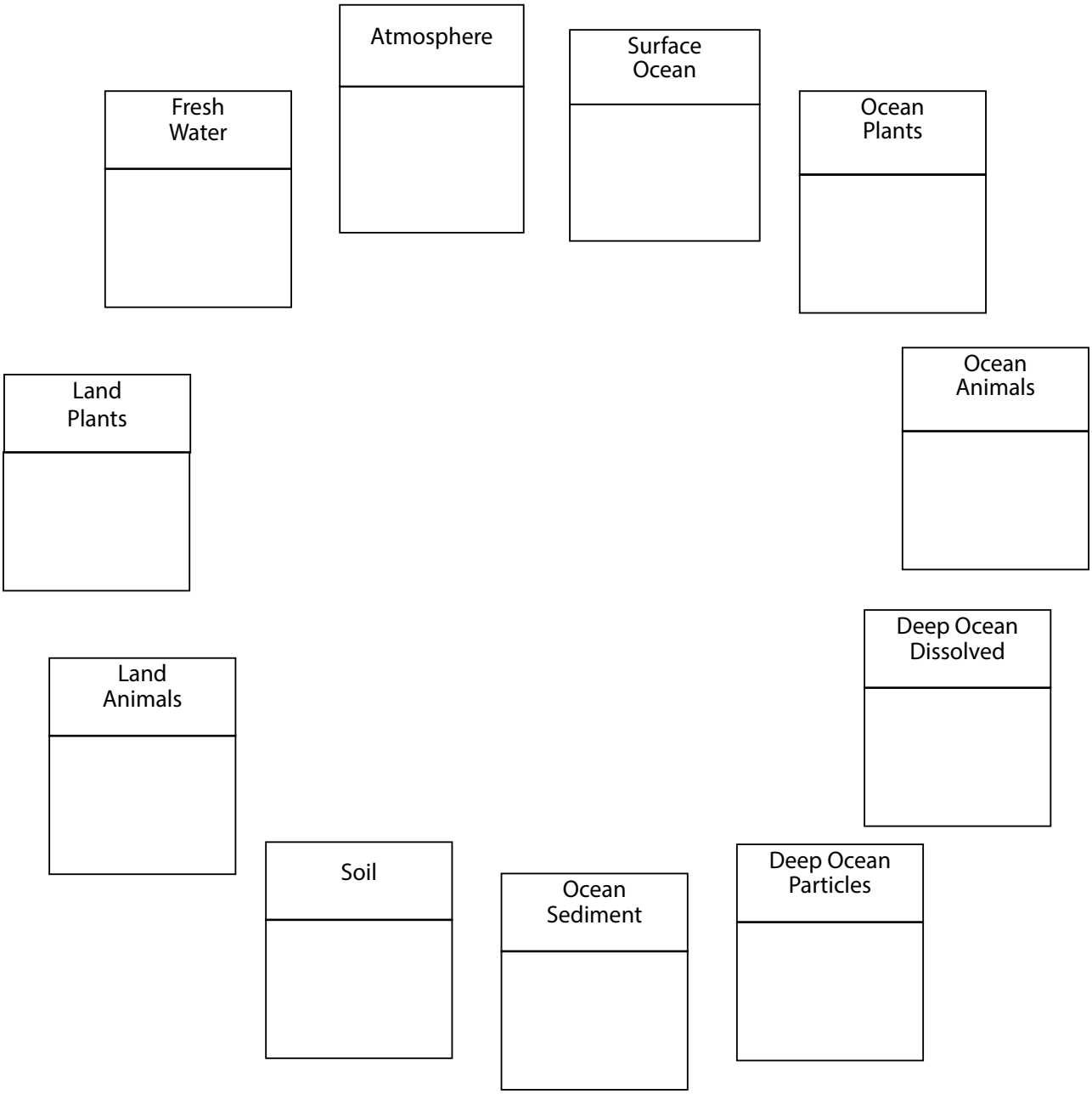
Student Worksheet: *The Carbon Cycle Game*

Name: _____

1. You are a carbon atom moving through the carbon cycle.
2. Next to "1" below, write the name of the reservoir where you start at (e.g., Atmosphere, Surface Ocean).
3. Roll the die.
4. Consult the Dice Number Chart. The number you roll indicates what reservoir you will visit next; write the name of that reservoir (e.g., Ocean Plants, Land Plants) in the next row of the chart. Note: If a die tells you to stay in place for a turn, you should write the name of that reservoir in the next row of the chart before re-rolling.
5. Read about the process that is moving you from one reservoir to another. Then go to your next station as instructed by the die.
6. Repeat 3 – 5 above till you fill out the chart (15 rounds).

#	Reservoir
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	

7. Consulting your game chart, indicate below how you (carbon atom) traveled, using arrows. Circle the reservoir where you started. Draw an arrow to the reservoir you visited next, and the next reservoir after that, etc. If you stayed in the same reservoir for more than one turn, add a horizontal arrow for each time you stayed in the same reservoir.



Discuss

Look at the diagram that you have just finished and answer the following questions.

1. Overall, which reservoirs were visited most?

   _____

2. Which reservoirs have long residence times and which have short residence times?

   Reservoirs with long residence times:

   _____

   _____

   Reservoirs with short residence times:

   _____

   _____

3. Is the carbon cycle a circle?

   _____

4. What are the processes that move carbon from one reservoir to another?

   _____

   _____

Student Worksheet: The Carbon Cycle Game

Name: _____

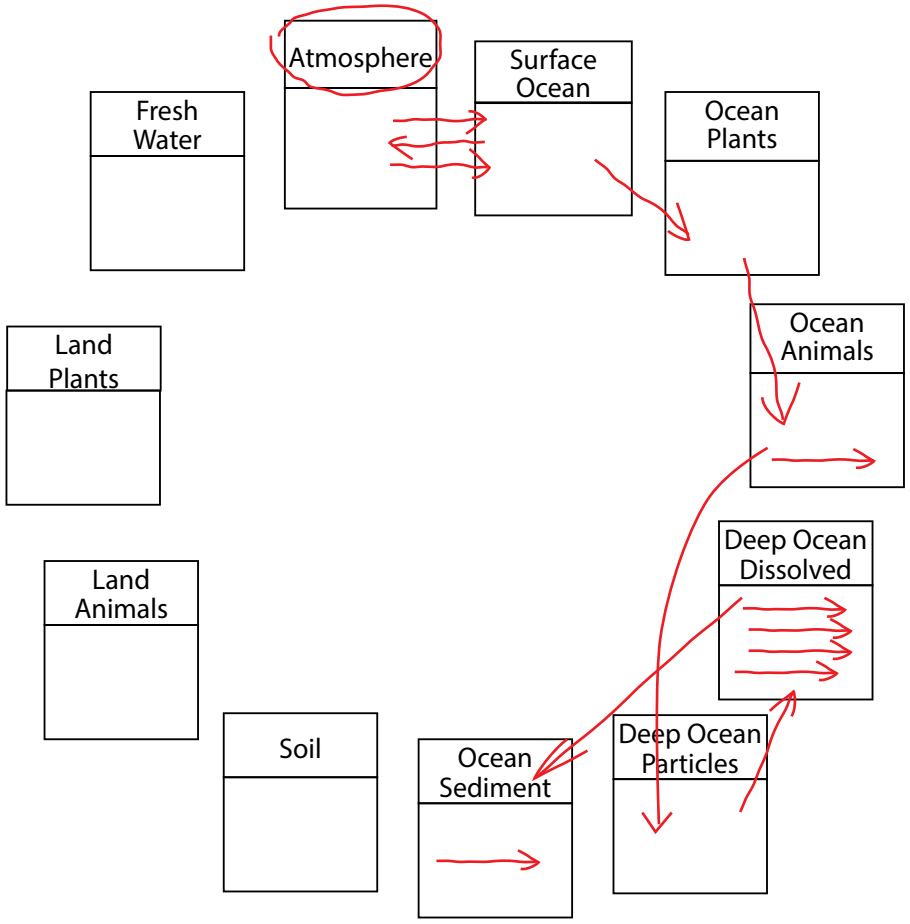
5. You are a carbon atom moving through the carbon cycle.
6. Next to "1" below, write the name of the reservoir where you start at (e.g., Atmosphere, Surface Ocean).
7. Roll the die.
8. Consult the Dice Number Chart. The number you roll indicates what reservoir you will visit next; write the name of that reservoir (e.g., Ocean Plants, Land Plants) in the next row of the chart. Note: If a die tells you to stay in place for a turn, you should write the name of that reservoir in the next row of the chart before re-rolling.
9. Read about the process that is moving you from one reservoir to another. Then go to your next station as instructed by the die.
10. Repeat 3 – 5 above till you fill out the chart (15 rounds)

Sample answers provided.

#	Reservoir
1	Atmosphere
2	Surface Ocean
3	Atmosphere
4	Surface Ocean
5	Ocean Plants
6	Ocean Animals
7	Ocean Animals
8	Deep Ocean, Particles
9	Deep Ocean, Dissolved
10	Deep Ocean, Dissolved
11	Deep Ocean, Dissolved
12	Deep Ocean, Dissolved
13	Deep Ocean, Dissolved
14	Ocean Sediments
15	Ocean Sediments

7. Consulting your game chart, indicate below how you (carbon atom) traveled, using arrows. Circle the reservoir where you started. Draw an arrow to the reservoir you visited next, and the next reservoir after that, etc. If you stayed in the same reservoir for more than one turn, add a horizontal arrow for each time you stayed in the same reservoir.

Sample answers provided.



Discuss

Look at the diagram that you have just finished and answer the following questions.

Sample answers provided.

1. Overall, which reservoirs were visited most?

   Deep Ocean, Dissolved

2. Which reservoirs have long residence times and which have short residence times?

   Reservoirs with long residence times:

   Deep Ocean Dissolved, Ocean Sedminents

   Reservoirs with short residence times:

   Atmosphere, Surface Ocean, Ocean Plants

3. Is the carbon cycle a circle?

   No, carbon travels all over Earth with no set pattern.

4. What are the processes that move carbon from one reservoir to another?

   Being eaten, being dissolved, being absorbed.

Student Worksheet: *The Carbon Cycle Review*

Name: _____

When you have completed "You are a Carbon Atom!" and "The Carbon Cycle Game," complete the following.

1. List three carbon sources:

   a. _____

   b. _____

   c. _____

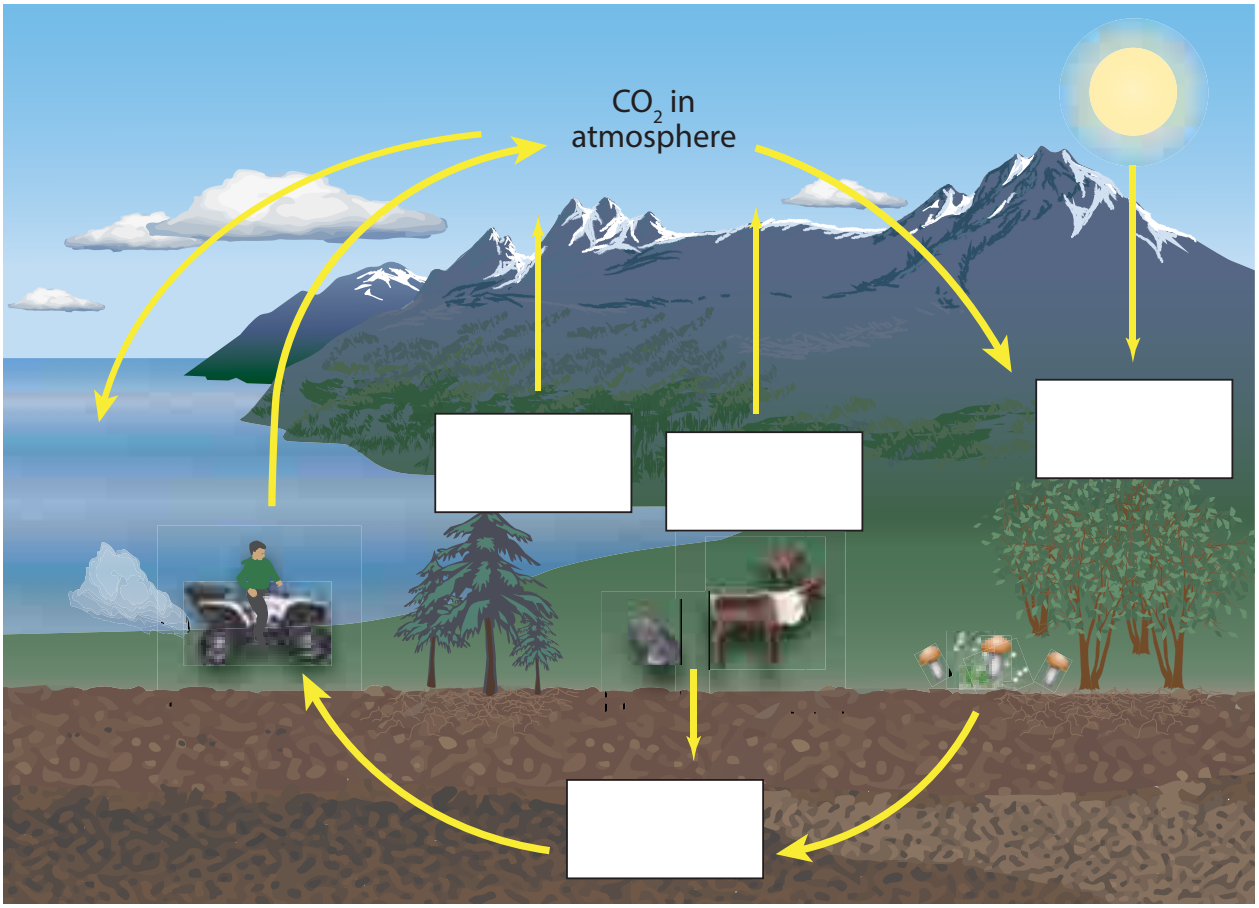
2. List three carbon sinks:

   a. _____

   b. _____

   c. _____

3. The following graphic shows three different ways that carbon can move. Look at the carbon cycle illustration and examine the processes that caused the movement. Add the following processes in appropriate boxes.
   a. Photosynthesis
   b. Respiration
   c. Decomposition



4. Explain in your own words below the three processes in which carbon moves.
   a. Photosynthesis:

_____

_____

_____

_____

   b. Respiration:

_____

_____

_____

_____

c. Decomposition:

_____

_____

_____

_____

5. List an example of carbon reservoir, carbon source and carbon sink and describe each in your own words.
   a. Reservoir:

_____

_____

_____

_____

   b. Carbon source:

_____

_____

_____

_____

   c. Carbon sink:

_____

_____

_____

_____

Activity MS.2.5: Does Sea Ice Prevent High Waves?

Overview

In this lesson students will compare 75% ice cover, 25% ice cover, and no ice cover of multiyear and first-year ice to learn how sea ice mitigates the effect of wind reaching the shore. Sea ice protects the shore from high waves and helps mitigation of coastal erosion.

Objectives

On successful completion of this lesson, students will be able to:

- describe two impacts of wind on the shore
- explain how sea ice mitigates shore erosion, using complete sentences
- compare and contrast multiyear ice and first-year ice
- describe the impacts sea ice loss could have on shorelines as the Earth continues to warm

Next Generation Science Standards

Standards by Disciplinary Core Ideas:

Earth's Systems
Earth and Human Activity

Standards by Topic: Weather and Climate

Performance Expectations

The activity is just one step toward reaching the performance expectations listed below:

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

Dimention:

Science & Engineering Practices

Developing and Using Models

Disciplinary Core Ideas

ESS2.C: The Roles of Water in Earth's Surface Processes

- The complex patterns of the changes and the movements of water in the atmosphere, determined by winds, landforms, and ocean temperatures and currents, are major determinants of local weather patterns. (MS-ESS2-5)

ESS2.D: Weather and Climate

- Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude,

altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns. (MS-ESS2-6)

- The ocean exerts a major influence on weather and climate by absorbing energy from the sun, releasing it over time, and globally redistributing it through ocean currents. (MS-ESS2-6)

ESS3.D: Global Climate Change

- Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming). Reducing the level of climate change and reducing human vulnerability to whatever climate changes do occur depend on the understanding of climate science, engineering capabilities, and other kinds of knowledge, such as understanding of human behavior and on applying that knowledge wisely in decisions and activities. (MS-ESS3-5)

Crosscutting Concepts

Cause and Effect
Stability and Change

Alaska Standards

Alaska Science Standards and Grade Level Expectations

SA1: The student demonstrates an understanding of the processes of science by

[6-8] SA1.1 asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring and communicating

[6] SA 1.2 collaborating to design and conduct simple repeatable investigations

[7] SA 1.2 collaborating to design and conduct simple repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.

[8] SA 1.2 collaborating to design and conduct repeatable investigations, in order to record, analyze (i.e., range, mean, median, mode), interpret data, and present findings.

SA3: The student demonstrates an understanding that the interactions with the environment provide an opportunity for understanding scientific concepts by

[6] SA 3.1 gathering data to build a knowledge base that contributes to the development of questions about the local environment (e.g., moose browsing, trail usage, river erosion)

[7] SA 3.1 designing and conducting a simple investigation about the local environment

[8] SA 3.1 conducting research to learn how the local environment is used by a variety of competing interests (e.g., competition for habitat/resources, tourism, oil and mining companies, hunting groups)

SF: The student develops an understanding of the dynamic relationships among scientific, cultural, social and personal perspectives.

Bering Strait School District Scope and Sequence

- **7.3D** Identify strategies (reforestation, dikes, wind breaks, off road activity guidelines) to minimize erosion. (SD2.1)
- **7.3F** Use scientific processes and inquiry to directly support concepts of erosion and deposition. (SA1.1, 1.2, 2.1, 3.1)
- **7.9G** Understands how currents and waves have distinct characteristics and impacts (SD1.2)
- **7.9H** Use scientific processes and inquiry to directly support concepts on oceans. (SA1.1, 1.2, 2.1, 3.1, SG)

Materials

- REACH Up Middle School Student Guide: *Environmental Cycles*
- Student Worksheet: *Does Sea Ice Prevent High Waves?*
- Rectangular pan
- Sand (silicate/dust free sand, such as play sand, for safety)
- Water
- Yarn
- Tape
- Straws
- Styrofoam pieces
- Bubble wrap
- Ruler
- Anemometer
- Measuring cup
- Paper towels / rags

Activity Preparations

1. Make copies of the Student Worksheet: Does Sea Ice Prevent High Waves?
2. The procedure instructs students to fill one side of the pan with sand. You can choose to do this part yourself. If the sand bag is big, you might find it easier if you use a cup to carefully pour sand to fill the pan on one side (some sand will slide down, and that's okay). You will need about 500ml (about 2 pounds) worth of sand for each pan (pan size about 9" x 12" x 1 1/2").

Activity Procedure

1. Read and discuss pages 11-12 of the Student Guide with the class and lead a discussion on the impact of climate change on students' and their community's environment and lifestyles.
2. Using the image on Page 11 and the graph on Page 12 of the Student Guide, discuss observed sea ice changes, possible consequences, and future projections. Lead a discussion on climate change's impact on the ocean, especially sea ice.
3. Preview Pages 13-14 of the Student Guide as a class. Explain the difference between multiyear ice and first-year ice, if necessary. Students can use the "Predict" section of the page to predict individually, as a pair or as a class.
4. Read the "Procedure" section of the Student Guide and review the safety rules of the activity.
5. Divide the class in groups so each group will have about 4 students. Distribute the Student Worksheet: Does Sea Ice Prevent High Waves? If necessary, review with the class the metric unit, centimeter.
6. Disrtibute materials and monitor students as they go through the activity.
    a. Make sure that students will carefully fill the rest of the pan with water. You will need about 1 liter of water for each pan (pan size about 9" x 12" x 1 1/2").
    b. Water may splash over the "shore" side of the pan when students create a "storm" by blowing into a straw. Make sure that no people stand on the "shore" side of the pan and that there are no objects that should not get wet on that side of the work station (including Student Guides). It may be a good idea to have a towel/rag handy.
    c. Monitor students so that they use the same speed of wind each time they blow across the water.
7. When all data has been collected, have students clean up their stations.
8. Discuss the result as a class, using the "Discuss" section of the Student Guide on Page 14. Have students compare their results with other groups' and lead a discussion on the impact of sea ice loss. Possible discussion topics may include:
    a. How does sea ice affect the severity of a storm on the shore and the areas beyond the shore?
    b. What is the impact of sea ice loss as the Earth continues to warm?
    c. Why do you think sea ice loss is important to coastal communities?
    d. What steps can we take as individuals and as a community to lessen the warming trend of the globe?

Student Worksheet: *Does Sea Ice Prevent High Waves?*

Name: _____

Multiyear Sea Ice

Sea ice	How waves move (How "sea ice" moves)	What happens to the shore (=sand) and the community (=beyond the pan)	Distance between initial and "after-the-storm" shorelines (cm)
75 % ice cover			
25% ice cover			
0% ice cover			

First-year Sea Ice

Sea ice	How waves move (How "sea ice" moves)	What happens to the shore (=sand) and the community (=beyond the pan)	Distance between initial and "after-the-storm" shorelines (cm)
75 % ice cover			
25% ice cover			
0% ice cover			

When you have completed the charts above, answer the questions below, using complete sentences:

1. Describe the impacts sea ice loss could have on shorelines:

_____

_____

_____

_____

2. Explain why sea ice loss is important to coastal communities:

_____

_____

_____

_____

Student Worksheet: *Does Sea Ice Prevent High Waves?*
Answer Key

Name: _____

Multiyear sea ice

Sea ice	How waves move (How "sea ice" moves)	What happens to the shore (=sand) and the community (=beyond the pan)	Distance between initial and "after-the-storm" shorelines (cm)
75 % ice cover	Waves hit the ice	No erosion	Answers will vary but most likely 0 cm
25% ice cover	Waves hit the shore where there was no ice	Erosion where there was no ice; the shoreline receded Some splashes of water over the pan	Answers will vary
0% ice cover	Large waves moved fast across the surface to the shore	Erosion Water over the pan	Answers will vary

First-year sea ice

Sea ice	How waves move (How "sea ice" moves)	What happens to the shore (=sand) and the community (=beyond the pan)	Distance between initial and "after-the-storm" shorelines (cm)
75 % ice cover	Waves hit the ice and ice moved with the waves	Some erosion; the shoreline receded Some splashes of water over the pan	Answers will vary
25% ice cover	Waves were higher; waves hit the ice and ice moved with the waves	Erosion where there was no ice Water wet the table beyond the pan	Answers will vary
0% ice cover	Even larger waves moved fast across the surface to the shore	Erosion Water wet the table beyond the pan	Answers will vary

When you have completed the charts above, answer the questions below, using complete sentences:

1. Describe the impacts sea ice loss could have on shorelines:

_____

_____

_____

_____

2. Explain why sea ice loss is important to coastal communities:

_____

_____

_____

_____